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Electronic Supplementary Material

Ratiometric optical thermometry based on Dy^{3+}, Eu^{3+} co-doped $GdAl_3(BO_3)_4$ phosphor

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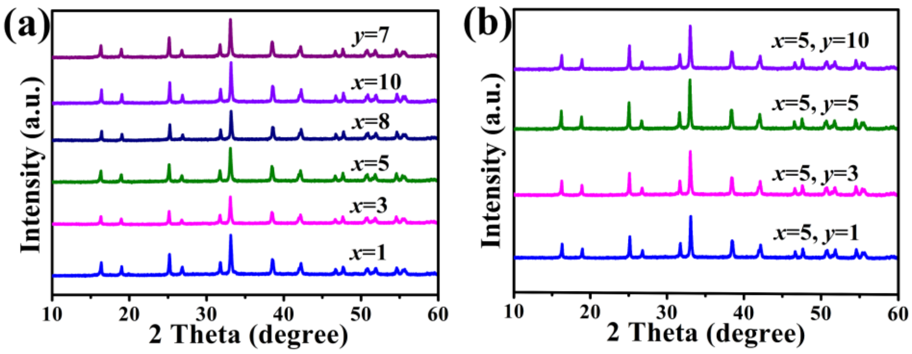

Fig. S1. XRD patterns of (a) the GAB: *x*% Dy^{3+} (*x*=1, 3, 5, 8 and 10), GAB: *y*% Eu^{3+} (*y*=7) and (b) the GAB: 5% Dy^{3+}, *y*% Eu^{3+} (*y*=1, 3, 5 and 10) phosphors.

Table S1. The ionic radii of Gd^{3+}, Dy^{3+}, Eu^{3+}, Al^{3+} and B^{3+} in the different fold of coordination.

Ion	Coordination	Ionic radius (Å)
Gd^{3+}	6	1.053
Dy^{3+}	6	1.027
Eu^{3+}	6	1.066
Al^{3+}	6	0.390
B^{3+}	3	0.110

Table S2. Parameters from Rietveld refinement of the GAB.

Atom	Occupancy	x	y	z	Uiso (Å^2)	Site
Gd	1	0	0	0	0.0312	3a
Al	1	0.5550 (5)	0	0	0.0230	9d
B1	1	0	0	0.5	0.0610	3b
B2	1	0.4180 (5)	0	0.5	0.0480	9e
O1	1	-0.1463 (8)	0	0.5	0.0240	9e
O2	1	0.5720 (2)	0	0.5	0.0032	9e
O3	1	0.8658 (8)	0.2940 (7)	0.5543 (10)	0.0280	18f

Table S3. Parameters from Rietveld refinement of the GAB: 5% Dy^{3+}, 7% Eu^{3+}.

Atom	Occupancy	x	y	z	Uiso (Å^2)	Site
Gd	0.8800	0	0	0	0.0200	3a
Dy	0.0499	0	0	0	0.0200	3a
Eu	0.0700	0	0	0	0.0200	3a
Al	1	0.5549 (5)	0	0	0.0040	9d
B1	1	0	0	0.5	0.0630	3b
B2	1	0.4210 (6)	0	0.5	0.0610	9e
O1	1	-0.1458 (9)	0	0.5	0.0160	9e
O2	1	0.5720 (2)	0	0.5	0.0064	9e
O3	1	0.8637 (9)	0.2935 (8)	0.5547 (11)	0.0150	18f

Table S4. Main bond lengths of the GAB and GAB: 5% Dy^{3+}, 7% Eu^{3+}.

Bond	Length (Å)
Gd1/Dy1/Eu1-O3	2.599 (9)
Al-O1	1.942 (6)
Al-O2	2.058 (14)
Al-O3	1.675 (8)
B1-O1	1.356 (9)
B2-O2	1.400 (6)
B2-O3	1.290 (3)

Table S5. Main bond angles of the GAB and GAB: 5% Dy^{3+}, 7% Eu^{3+}.

Bond	Angle (°)
O3-Gd/Dy/Eu-O3	77.6 (4)
	86.2 (3)
	101.89 (18)
	120.7 (3)
	146.9 (3)
O2-Al-O3	172.2 (5)
O1-Al-O3	90.8 (4)
O1-Al-O2	81.8 (5)
O3-Al-O3	83.4 (6)
O2-Al-O2	88.10 (19)
O1-Al-O1	170.0 (4)
O1-B1-O1	120 (4)
O3-B2-O3	131 (4)
O2-B2-O3	115 (2)

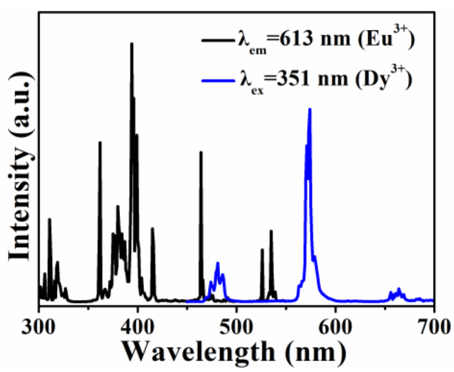

Fig. S2. The PL spectrum of GAB: 5% Dy^{3+} phosphor under 351 nm excitation and PLE spectrum of GAB: 7% Eu^{3+} phosphor monitored at 613 nm.

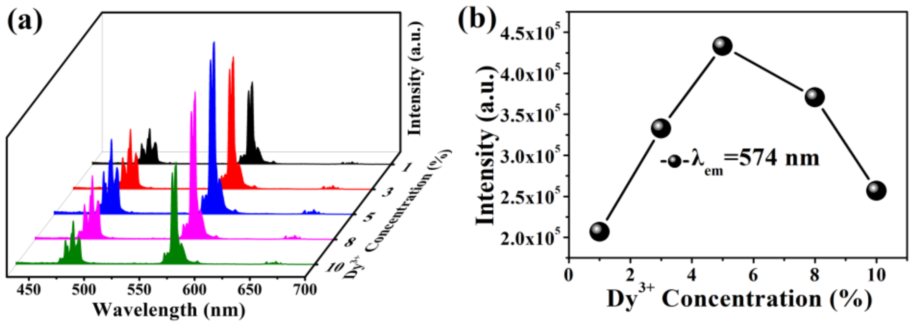

Fig. S3. (a) The PL spectra and (b) the Dy^{3+} concentration-dependent emission intensity at 574 nm of GAB: *x*% Dy^{3+} (*x*=1, 3, 5, 8 and 10) phosphors under 351 nm excitation.

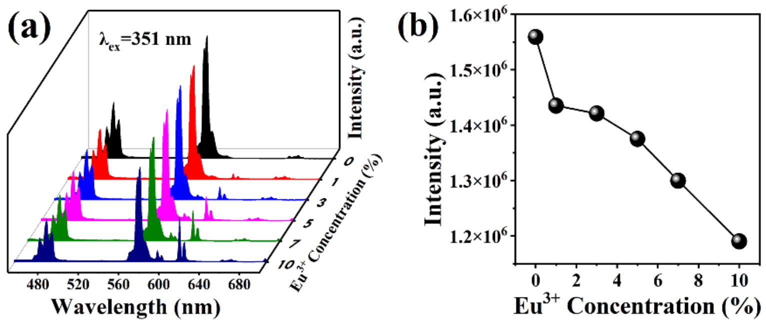

Fig. S4. (a) The PL spectra and (b) the Eu^{3+} concentration-dependent emission intensity at 574 nm of GAB: 5% Dy^{3+}, y% Eu^{3+} (*y*=0, 1, 3, 5, 7 and 10) phosphors under 351 nm excitation.

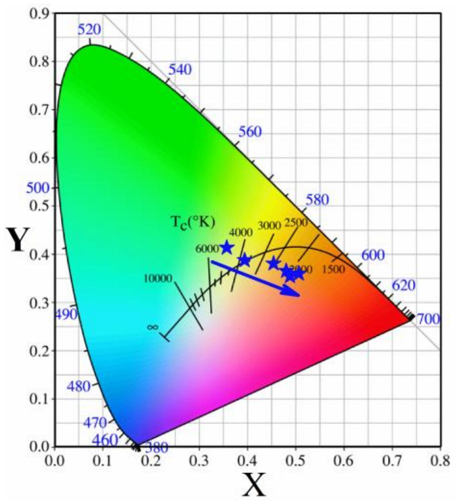

Fig. S5. The CIE chromaticity diagram of GAB: 5% Dy^{3+}, *y*% Eu^{3+} (*y* = 0, 1, 3, 5, 7 and 10) phosphors at room temperature.

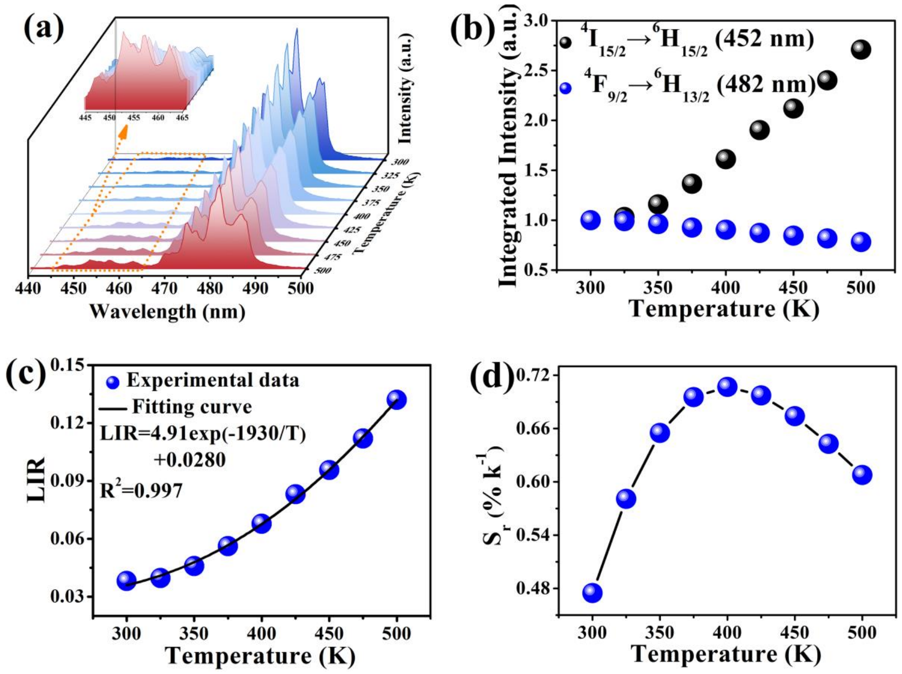

Fig. S6. (a) The temperature-dependent emission spectra of GAB: 5% Dy^{3+} phosphor under 351 nm excitation from 300 to 500 K. The inset shows the enlarged view for the wavelength region of 445-465 nm. (b) The temperature-dependent integrated emission intensity relative to that at 300 K. The integral regions are 445-465 nm and 466-496 nm, respectively. (c) The LIR fitting curve and (d) the S_r of GAB: 5% Dy^{3+} phosphor.

Table S6. Comparison of S_r of different optical thermometers based on LIR technology.

Materials	Temperature Range (K)	S_{rmax} (% K^{-1})	Ref.
$BiVO_4:Nd^{3+}$ (NPs)	310–523	1.53 (310 K)	[1]
Ca_2LaNbO_6: Pr^{3+}	313-573	0.89 (523 K)	[2]
$LaMgNbO_3$: Pr^{3+}	298-523	0.73 (473 K)	[3]
Y_2O_3: Yb^{3+}, Tm^{3+}	298-573	0.66 (298 K)	[4]
Gd_2O_3: Yb^{3+}, Er^{3+}	298-578	1.51 (298 K)	[5]
g-C_3N_4/$BaWO_4$: Yb^{3+}, Er^{3+}	293-393	1.47 (393 K)	[6]
$Ca_2NaMg_2V_3O_{12}$: Eu^{3+}	303-503	1.67 (443 K)	[7]

$NaLuF_4$: Eu^{3+}@g-C_3N_4	303-503	0.46 (383 K)	[8]
$LiCa_3MgV_3O_{12}$: Eu^{3+}	303-523	1.69 (383 K)	[9]
$Sr_3Y(PO_4)_3$: Ho^{3+}/Yb^{3+}	298-573	1.11 (298 K)	[10]
GAB: Dy^{3+}	300-500	0.71 (400 K)	This work
GAB: Dy^{3+}, Eu^{3+}	300-500	1.37 (475 K)	This work

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